REMARKS

In view of the Office Action and the restriction/election requirement, claims 1, 2, 5-8, 12, 14, 20-21, 25, and 32 are pending, and claims 4, 9, 15-19, 22-24, 26-27, and 30-31 have been withdrawn without prejudice and while preserving applicant's right to rejoin upon allowance of a generic claim. Favorable re-consideration is requested.

In line with the Examiner's comments, applicant has amended "capacitive element" to "capacitor" in claim 25, as supported by the specification, e.g., page 5, line 15. Claim 32 has been amended to use the more typical spelling of azimuthal. No new matter has been added.

In response to the rejection of claim 32 under Section 112, first paragraph, as allegedly failing to comply with the written description requirement, applicant traverses the rejection for at least the following reasons.

The Examiner contends that "*the specification, as originally filed, does not provide support for 'wherein the apparatus is adapted such that the antenna has a sinusoidal current distribution in function of the azimuthal angle*'." This is incorrect.

The technical effect "*a sinusoidal current distribution in function of the azimutal angle*" is clearly disclosed in the specification, e.g., at page 3, lines 14-16. This technical effect is the result of the special shape of the antenna as defined in claim 1, which is described in the detailed description at page 5, lines 8-12 and in the Figures 1, 2, 3, 4 and 6, when a RF power supply gives energy to the antenna as disclosed at page 6, lines 5-8 and Figures 2, 3 and 5.

A person skilled in the art has nothing more to do than choosing that shape of the antenna and supplying the antenna. He then obtains, in the antenna, a sinusoidal current distribution in function of the azimuthal angle. As a result, the apparatus is clearly "adapted" so that the antenna has such a distribution of current.

In the applicant's previous response filed on August 16, 2010, at page 9, applicant has clearly shown that the inventor made measurements of the current amplitude as a function of the leg number in a birdcage antenna according to claim 1, and those measurements have shown a current distribution that is sinusoidal. Such a sinusoidal distribution of current is well known by the person skilled in the art in birdcage coils such as those of claim 1:

- theoretical predictions of the distribution of currents have been calculated for instance in the reference book titled ELECTROMAGNETIC ANALYSIS AND DESIGN IN MAGNETIC RESONANCE IMAGING, from Jianming Jin (CRC press), as shown on the attached copy of pages 146-149; and
- similar theoretical predictions and experimental measurements have been made by the inventors themselves, and then published on October 20, 2005: see the attached copy of the publication in the JOURNAL OF APPLIED PHYSICS 98, 083304 (2005).

For at least the foregoing facts and reasons, claim 32 complies with 35 USC § 112, first paragraph.

Claim 32 stands rejected under Section 112, second paragraph, as allegedly being indefinite. Applicant traverses this rejection for the reasons stated previously, for the above reasons, and for the following reasons.

Claim 32 distinctly claims the following subject matter: a plasma source apparatus according to claim 1, with an antenna, a plasma generation chamber, a fluid injector, a radio frequency generator, magnetic field generators, conductive loop elements and axial conductive elements electrically interconnecting the loop elements (that is, a birdcage antenna), capacitors,

and RF generator which gives energy to the antenna so that there is, in the axial conductive elements, a distribution of current which is sinusoidal in function of the azimuthal angle.

The above explanations regarding the rejections under 35 USC § 112 are believed clear. However, if the Examiner has some difficulties understanding what is the "azimuthal angle," applicant respectfully suggests looking at the attached Figures A and B.

Figure A shows a top view of a birdcage according to claim 1, with 16 axial conductive elements numbered 1-16 connected to the top loop element. Figure B shows the same antenna in perspective, with the top loop element and axial elements such as 1, 2 and 3. In Figure A, the azimuthal angle A is the angle around the circle of the top loop element, from the first axial conductive element 1. The angle A is growing from the second loop element 2 until the 16^{th} loop element 16. The respective currents flowing through the axial elements 1-16 are different from each other, and the amplitude of those currents are distributed according to a sinusoidal law, as shown on the Figures on page 9 of applicant's previous response filed on August 16, 2010.

For example, in the first Figure regarding mode m = 1, the amplitude of the axial conductor 1 is nearly zero, the amplitude of the axial conductor 2 is higher but negative, the amplitude of the axial conductor 3 is still higher and negative, and so on.

For at least the foregoing facts and reasons, claim 32 complies with 35 USC § 112, second paragraph.

The following prior art rejections have been asserted in the Office Action:

1. On pages 3-5 of the Detailed Action, claims 1-2, 5, 8, 12, 21, 25, and 32 stand rejected under 35 U.S.C. 103(a) as allegedly being obvious over Bennett, U.S. Patent 6,495,963 in view of Campbell et al, U.S. Patent 4,990,229 and Kwon et al, U.S. 2002/0189763 or Howald et al, U.S. Patent 6,441,555.

2. On page 6 of the Detailed Action, claims 6 and 20 stand rejected under 35 U.S.C. 103(a) as allegedly being obvious over Bennett, U.S. Patent 6,495,963 in view of Campbell et al, U.S. Patent 4,990,229 and Kwon et al, U.S. 2002/0189763 or Howald et al, U.S. Patent 6,441,555 as applied to claims 1-2, 5, 8, 12, 21, 25, and 32 above, and further in view of Saito et al, U.S. Patent 5,728,253 or Durr, U.S. Patent 5,180.949.

3. On pages 6-7 of the Detailed Action, claim 7 stands rejected under 35 U.S.C. 103(a) as allegedly being obvious over Bennett, U.S. Patent 6,495,963 in view of Campbell et al, U.S. Patent 4,990,229 and Kwon et al, U.S. 2002/0189763 or Howald et al, U.S. Patent 6,441,555 as applied to claims 1-2, 5, 8, 12, 21, 25, and 32 above, and further in view of Collins et al, U.S. Patent 6,024,826.

4. On page 8 of the Detailed Action, claim 14 stands rejected under 35 U.S.C. 103(a) as allegedly being obvious over Bennett, U.S. Patent 6,495,963 in view of Campbell et al, U.S. Patent 4,990,229 and Kwon et al, U.S. 2002/0189763 or Howald et al, U.S. Patent 6,441,555 as applied to claims 1-2, 5, 8, 12, 21, 25, and 32 above, and further in view of Hashimoto, U.S. Patent 6,096,232 or Okumura et al, U.S. Patent 5,888,413 or Yoshida et al, U.S. Patent 5,690,781.

Applicant traverses the prior art rejections for at least the following facts and reasons and those stated in applicant's Amendment filed on August 16, 2010.

Respectfully stated, the Examiner is incorrect when stating that applicant has only attacked the references individually. As set forth in applicant's Amendment of August 16, 2010, applicant has properly attacked the references first individually and then in combination. This is standard practice. See applicant's detailed Remarks on pages 11-15 of applicant's Amendment filed on August 16, 2010.

Applicant also submits the following facts and information.

Bennett is the primary reference cited in each rejection. Regarding the Examiner's comments on Bennett on page 10 of the Office Action, Figure 12 of Bennett does show several loop elements (13a) which form one part of the entire loop, but the loop elements are not spaced

"along" the common longitudinal axis and are not interconnected by axial conductive elements from each other. These are major defects in the primary reference.

As stated in applicant's previous response, the closed top loop and bottom loop of Figure 12 of Bennett are NOT part of the antenna because they do not generate any magnetic field. These facts are indisputable.

Applicant does not understand the Examiner's opinion when he respectfully disagrees with applicant regarding the portions 14a and 14b of Bennett. According to the applicant and those skilled in the art and standard science, these portions are not part of the antenna because they do not generate a magnetic field (because 14a and 14b are close to each other). There is no scientific support to say otherwise.

Regarding the patentable weight of the generation of plasma by helicon waves, applicant does not understand the Examiner's reasoning. Here, the generation of helicon waves is closely related to the structural limitations of the antenna: the antenna is a resonant antenna (page 3, line 14) which generates a sinusoidal distribution of current (page 3, line 15) as claimed in claim 32, and such a distribution generates helicon waves that efficiently produces high-density plasma (see the specification page 1, lines 9-10 and page 6, line 13). Again, there is no scientific support to say otherwise.

Once again, applicant notes that the prior art rejection of independent claim 1 fails to show a prima facie case of obviousness for at least the following reasons.

A. BENNETT - USP 6,495,963

Bennett fails to disclose the following key features of claim 1:

1. *"magnetic field generators arranged around the antenna"*

Bennett does not disclose an apparatus comprising magnetic field generators arranged around the antenna.

2. *"said antenna comprises at least two conductive loop elements"*

It is again important to emphasize that an antenna is made of electric conductors that generate an electric or magnetic field, and that the antenna is supplied by supply conductors. The supply conductors do not generate any electric or magnetic field; thus, they are not part of the antenna.

In contrast to the claimed invention, Bennett discloses, in Figures 9-13 and their descriptions, an antenna comprising only one conductive loop, namely, the loop (coil 13) constituted by a plurality of coil portions (13a). The coil portions 13a constitute a single coil - see column 3, lines 56, 57. The electric current flowing in any part other than the segments of coil 13a is balanced by a current flowing in an opposite sense in an adjacent part, so that they do not generate any electric or magnetic field - see column 1, lines 27-30. As a result, the parts other than the segments 13a are supply conductors, and are not part of the antenna:

- e.g., in Figure 9, the leads 14a and 14b are *"input lead* and *output lead"* (column 4, line 14), the lines 16 are *"feed lines"* (column 4, line 15),
- in Figures 11 and 12, the rings 12a and 12b are "*connecting rings*" (see column 5, lines 8-12), and are not parts of the antenna: opposite currents will flow in the rings, the currents are balanced, and the rings do not generate any electric or magnetic field.

If we consider that Bennett discloses several conductive elements 13a, then each of those elements 13a is not a *"loop,"* and does not surround the common longitudinal axis.

Accordingly, Bennett fails to disclose the claimed "*said antenna comprises at least two conductive loop elements.*"

3. *"spaced along a common longitudinal axis"*

In Bennett, there is only one loop element 13. Accordingly, the feature *"spaced along"* is not disclosed in Bennett.

4. *"a pair of axial conductive elements electrically interconnecting said conductive loop elements"*

In Bennett, there is only one loop element in the antenna. Accordingly, the feature *"interconnecting"* is not disclosed in Bennett. In this regard, the conductive elements (14a, 14b) are not *"axial conductive elements"* in Figure 9 of Bennett. They are radial elements. In addition, the conductive elements 14a and 14b in Figures 11 and 12 are feeding elements which interconnect the only one loop element of the antenna with feeding rings 12a and 12b which are not part of the antenna. Consequently, those conductive elements do not electrically interconnect several loop elements of the antenna.

5. *each loop element including at least one capacitor*

Bennett fails to disclose this feature because the capacitors (18) are present in relation with only one loop element. Furthermore, Bennett fails to disclose capacitors which are inside the conductive loop elements, and which are therefore part of the antenna. In Bennett, the capacitors are between two supply conductors, namely, 14a, 14b, and are not between the segments 13a of the antenna.

6. *The technical effects*

As demonstrated above, there are many key differences between the features of the antenna of Bennett and the features of the antenna of claim 1. These differences are important because they result in very different effects, namely, very different generated electric fields.

In the present invention, as stated in claim 1, by the feature "*for plasma generation by helicon waves,*" the sinusoidal distribution of current amplitude within the antenna legs (the axial conductive elements) results in transverse fields that generate helicon waves in the area inside the antenna.

In contrast, in Bennett, the generated fields are not transverse, but are parallel to the longitudinal axis, as is always the case in a coil. See Figure 8. Signficantly, this will not generate helicon waves.

All of the foregoing deficiencies of Bennett are not overcome by the secondary references. Nor would a person skilled in the art use Bennett's apparatus and reasonably modify it (or destroy it) to arrive at the claimed invention. Not even with improper hindsight would a person skilled in the art do so.

B. CAMPBELL - USP 4,990,229

Campbell does teach magnetic fields generators (16, 17) arranged around the antenna (15). See column 7 lines 41-44. However, Campbell fails to disclose the important claimed feature of *"a pair of axial conductive elements electrically interconnecting said conductive loop elements."* For example,

- In Figure 4, the loop elements (1, 2) are connected by only one axial conductive element (5). The conductive elements (6) are feeding elements which each connect a loop element (1 or 2) to the matching box (9) which supplies the antenna.

- In Figure 5, there is only one axial conductive element (12) which connects the loop elements. The other conductive elements (13) each connect a loop element to the matching box.

Campbell fails to disclose capacitors in the conductive loop elements. Accordingly, when trying to combine Bennett and Campbell, the feature of *"a pair of axial conductive elements electrically interconnecting said conductive loop elements"* is still missing.

C. KWON - US Pat Pub 2002/0189763 A1

In Kwon, the antenna is planar. As a result, Kwon fails to disclose the missing feature of any combination of Bennett and Campbell, i.e., *"a pair of axial conductive elements electrically interconnecting said conductive loop elements."*

D. HOWALD - USP 6,441,555 B1

Howald discloses a spiral-like coil (see the abstract line 1, see Figure 2) which is planar (see column 5, lines 64-65, column 30, column 11, line 50). Accordingly, Howald fails to disclose the missing feature of a combination of Bennett and Campbell: *"a pair of axial conductive elements electrically interconnecting said conductive loop elements."*

For at least the foregoing reasons, there is no prima facie case of obviousness of claim 1 – from which all claims depend. The rejections fail to show how any combination of the cited documents include all the important features of claim 1, including the feature of *"a pair of axial conductive elements electrically interconnecting said conductive loop elements."* In this regard, Howald and Kwon show capacitors inside the loops. However, the rejection of claim 1 has not

shown why a person skilled in the art would be encouraged or motivated to somehow adapt the capacitors of Howald or Kwon into the antenna of Bennett or a combination of Bennett and Campbell.

As demonstrated by the facts above, claim 1 is not rendered obvious by any combination of the references. For at least the same reasons, the dependent claims are not rendered obvious.

Applicant submits that the application is in condition for allowance. A notice to that effect is earnestly solicited.

If the Examiner has any questions concerning this case, the undersigned may be contacted at 703-816-4009.

Respectfully submitted,

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